RESEARCH IMPLEMENTATION REPORT 2006

FROM: PROJECT SPR-555,
Atmospheric Effects Associated with Highway Noise Propagation

ARIZONA TRANSPORTATION RESEARCH CENTER

MARCH 2007

Arizona Department of Transportation

Welcome

The 2006 Research Implementation Report is the fourth annual report by the Arizona Transportation Research Center (ATRC) on research implementation. Every step of the research process is important, from problem development through research studies, including the final report. However, implementation serves as an important test of the value of a transportation research program.

Quantifying the benefits of the ATRC research program is still an elusive goal. That does not prevent a close look at project results which enables the Arizona Department of Transportation (ADOT) to gain a clear understanding of how a research study has benefited ADOT.

The implementation results presented were documented by ATRC staff. Information was gathered from the primary research clients and project technical advisory committees (TACs). During 2006 a new, standardized ATRC research implementation form was used to document implementation information. The form is designed to create a consistent format for research customers to use to help them compile data related to implementation.

One of the difficult elements of documenting implementation is knowing who is using research results. While ATRC starts the search with the original customer and project TACs, many other potential users of the information may develop. This knowledge is important in both documenting the success of the research program and helping ATRC continue to improve its processes. Another challenge in gathering information on research implementation is that the time frame for implementation can vary greatly from one project to another. Implementation for one project may be completed in a few weeks. Other projects may result in implementation continuing for years. All this information is useful and valuable in evaluating and improving the ATRC research program.

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About the Arizona Transportation Research Center

The Arizona Department of Transportation (ADOT) conducts research on a wide range of transportation topics. The Department's research effort is administered by the Arizona Transportation Research Center (ATRC), which has immediate responsibility for the management and conduct of research. During 2006 the ATRC research program was guided by the Research Council, which provided direction on research priorities.

The Arizona Transportation Research Center is located at 2739 East Washington Street, Phoenix, Arizona.

ATRC STAFF

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ATRC manages the ADOT transportation research program, including conducting in-house research, coordinates the ADOT product evaluation program, houses and operates the ATRC Library, and provides direct financial support for ADOT's Local Technical Assistance Program (LTAP).

Each year ATRC solicits research proposals throughout ADOT and the transportation community. In meetings with individual offices or in Department-wide needs assessment meetings, ADOT personnel are asked to suggest research pertinent to their areas. ATRC also invites suggestions from academia, consultants, and industry. Research suggestions are solicited through personal contact, newsletters, electronic communications, and the Internet.

The ATRC research program is currently grouped into seven emphasis areas. These areas are:

- Environment
- Intelligent Transportation Systems (ITS)
- Maintenance
- Materials and Construction
- Planning and Administration (including Motor Vehicles, and Information Technology)
- Structures
- Traffic and Safety

New projects are assigned to one of these areas. A project manager is assigned to each project. Technical advisory committees are formed for each project to work with the project manager on developing work scopes, reviewing and guiding the progress of the research, and reviewing the final report.

Small Budget Projects

The Arizona Transportation Research Center integrates opportunities for university students and small consulting firms into its research program. Each year ATRC allocates up to $100,000 for small budget projects ($15,000 or less) that often provide opportunities to contract university students and small consulting firms for transportation research. ATRC enthusiastically encourages future transportation professionals and small business. This strategy provides opportunities for individuals to learn first hand about the role of research and technology in the Nation's transportation system, and the variety of available transportation career or business options. The results have been high quality research that makes effective use of the ATRC research budget while providing valuable professional experience for students and small businesses.

Research Implementation

Implementation may range from assisting an entity in making a decision, to a change in operational strategies or activities. Implementation of research results often occurs over a period of several years. As such, implementation that occurred during 2006 will be addressed in this report, including actions associated with projects completed prior to 2006. The discussion is grouped by research emphasis area.

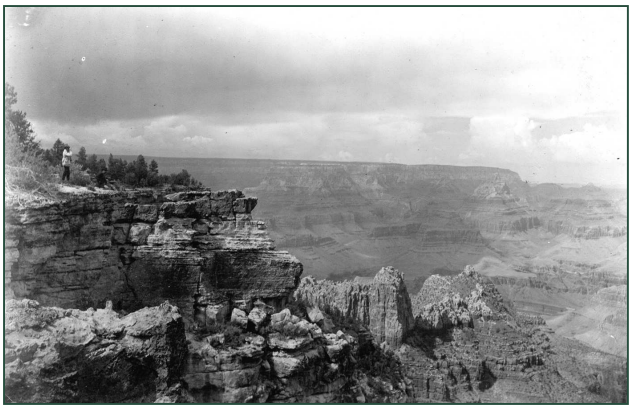
Implementation during 2006 affects roadway construction, maintenance, safety, and performance. Research results included the development of new tools that will assist ADOT in managing roadside noise, making better use of technology to reduce hazards for snowplow drivers, road safety enhancements, improved construction and maintenance cost assessments, and saving money and reducing environmental contamination by more efficient pavement recycling methods.

Completed Projects

During calendar year 2006, 17 research projects were completed under ATRC management. *Appendix A* includes a list of these projects. All these projects are examples of applied research. As such, implementation of the research results is the ultimate measure of the success of the research.

Knowledge is not achieved until shared.

ENVIRONMENT

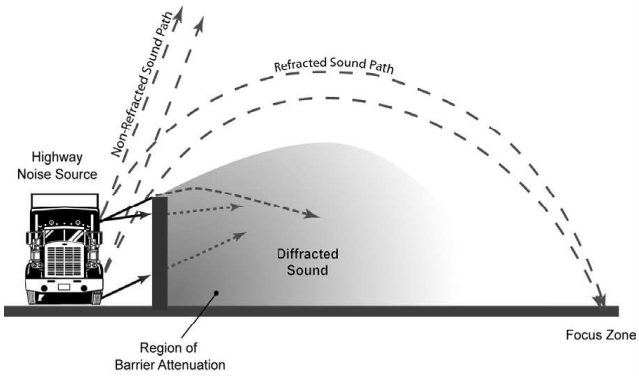


SPR-555: *Determination of Atmospheric Effects on Highway Noise Propagation*

Project Cost
$169,900

Summary
Management of highway noise is an important ADOT objective. This study focused on how atmospheric conditions affect long distance sound propagation in the Salt River Valley in the Phoenix metropolitan area.
The conclusions reached were:

(1) The nighttime atmospheric temperature inversion condition that is common from October through March results in sound level increases averaging from 5 to 8 decibels (dB) at distances greater than ¼ mile from freeways. This appears to be a year-round phenomenon since nighttime inversions occur in the warm weather months as well.



(2) The nighttime down-slope air drainage flows off the mountain ranges surrounding the Phoenix area cause localized focusing and de-focusing of sound levels. These can be consistent patterns over several days or can be isolated events occurring over periods of 15 to 20 minutes. Focusing and de-focusing effects on the order of +4 to -10 dB were observed during the measurements.

The highest sound levels during the October to March period will usually occur around sunrise when high traffic volumes coincide with strong inversion conditions. The loudest hour during the March and October measurements was consistently 6 a.m. The loudest hour is likely to shift with seasonal changes in sunrise and sunset.

Implementation
Implementation may entail adjustments that are made in response to these findings to help insure that traffic noise surveys and measurements capture the peak noise levels that residents and businesses may be exposed to. The Air and Noise team of the ADOT Environmental Services Group is utilizing the material presented in this report as a tool in planning noise surveys and schedules. In particular, where noise measurements are initiated in response to public concerns, this report provides useful tools for targeting peak traffic noise levels.

SPR-572: *Evaluation of Benefits and Opportunities for Innovative Noise Barrier Designs*

Project Cost
$44,036

Summary
The research focused on evaluating whether innovative noise barrier designs have the potential to reduce overall wall height and cost during initial construction, and substitute for costly retrofit wall height increases or wall replacement.

The study provided the following recommendations for ADOT consideration. One is to employ a T-top noise wall design with absorptive material placed on the top of the horizontal portion of the barrier. The second is to use vertical barriers with absorptive material applied to the face of the barrier. These two barrier designs have been shown in the available literature to reduce noise levels by up to 3 decibels, which could reduce overall barrier heights by as much as 3 to 5 feet compared with a conventional noise barrier of concrete or masonry block construction.

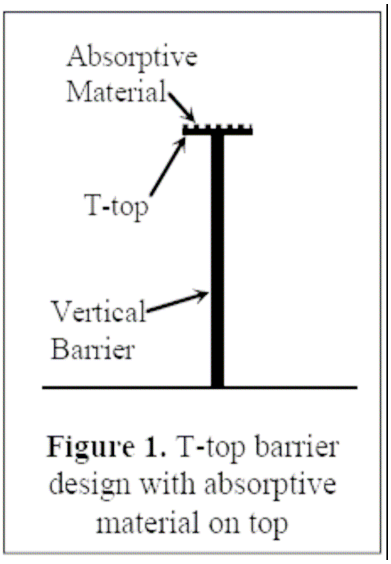
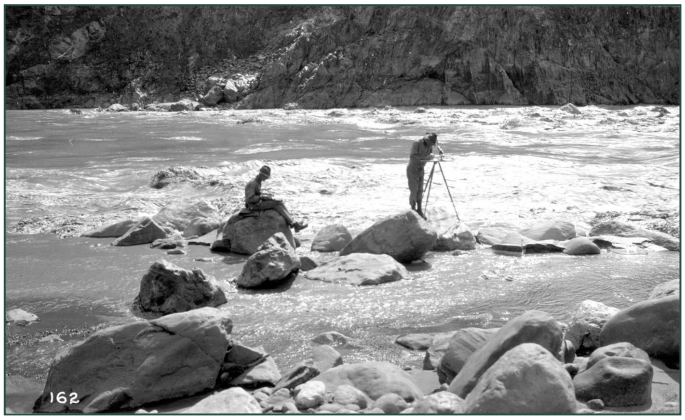


Figure 1. T-top barrier design with absorptive material on top

Implementation
Typically ADOT will consider unconventional noise mitigation structures in special situations. When such needs arise, the potential exists to employs one or more of the barrier designs discussed in this study's recommendations. The ADOT Air and Noise team will be asked to review the study recommendations with a view to determining the circumstances and extent of possible use on ADOT projects in the future.

INTELLIGENT TRANSPORTATION SYSTEMS



SPR-473: *Arizona Intelligent Vehicle Research (Phase 5 - Long-Term Evaluation)*

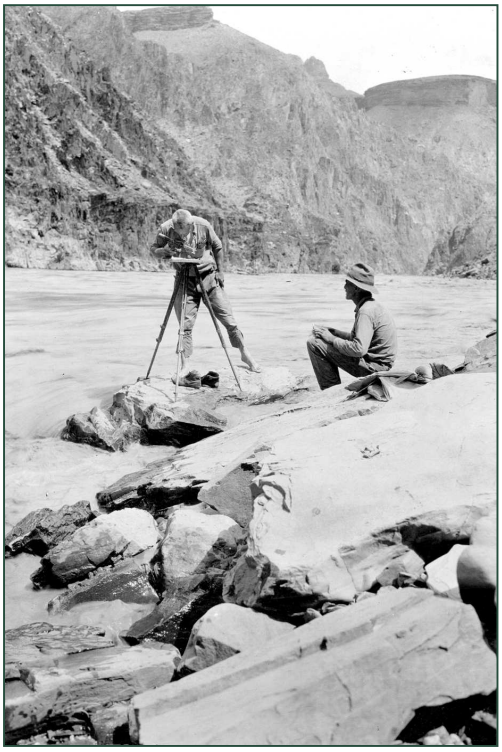
Project Cost
$290,956

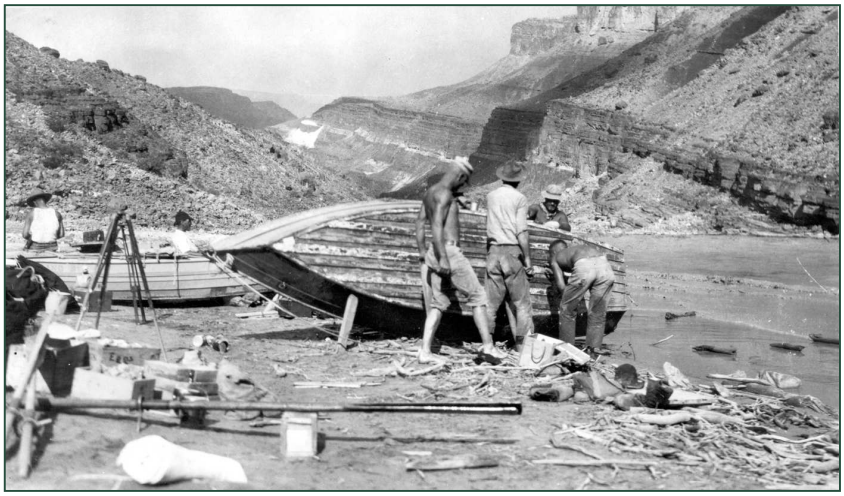
Summary
This Intelligent Vehicles (IV) project was the result of ADOT visits to the National Automated Highway Systems (AHS) Demonstration in San Diego, California in 1997. The project concept is to evaluate Intelligent Transportation Systems (ITS) driver assistance and guidance technology for maintenance vehicles in severe winter storm conditions.

The Arizona Transportation Research Center (ATRC) is conducting this project in-house. Eight winters of testing and evaluation have now been completed. Phased project reports were published by ATRC in February 2001, May 2002, September 2003 and January 2004. ATRC continues to monitor implementation and field evaluation of installed IV snowplow collision warning systems with internal reports being released in August 2004 and July 2005. Additional rear blind-spot warning devices were evaluated for the 2005-06 winter, and recommendations on these devices were published for internal stakeholders in August 2006.

Implementation

Requests to add more primary Radar or Night Vision warning systems in individual districts (at their cost) were not successful. However, all units (7 total) remain in service with only minor problems noted. A field evaluation of Eaton Corp backing-warning systems was completed on four trucks at Kayenta, Kingman, Three Points, and Tucson between October 2005 and May 2006. This evaluation compared these radars with rear-view cameras installed on seven vehicles in the ADOT Tucson District. As a result, additional ADOT vehicles are being equipped with the Eaton backing-warning systems.





SPR-460: *Evaluation of Cold In-Place Recycle Methods*

Project Cost
$18,944

Summary
An important pavement cost control strategy is to improve the preservation of existing pavements. One means of preservation is pavement recycling. Although pavement recycling is reported to have been done as early as 1915, its principal use has been since the mid-1970s. Recycling consists of both hot and cold recycling which can both be done in place or off site.

Cold in-place recycling has seen ever-increasing use due to improvements in technology, longer performance records, and greater emphasis on quality control. The two primary types of cold in-place recycling are full-depth or partial-depth recycling. Partial-depth recycling is more prevalent and generally consists of rehabilitating the top 2 to 4 inches of the pavement structure. Some agencies require the placement of an overlay or wearing surface on top of the cold recycled material while other agencies allow cold recycle as the final wearing surface.

Although ADOT has constructed several cold in-place recycled projects, only limited experience exists with some of the different binder types and construction techniques. Since cold in-place recycling potentially offers considerable economic advantages, research was conducted to establish the best techniques and binders for use in construction and to begin to establish the life cycle costs of these design strategies.

Implementation

The ADOT Pavement Management group is currently recommending the use of cold in-place recycling as a rehabilitation strategy in all projects that meet minimum criteria. Cold in-place recycling projects have a cost savings of approximately 40% over the overlay portion of a pavement rehabilitation project. As an added benefit this technique often eliminates the need to adjust the roadway guardrail. Further, cold in-place recycling reduces the emissions from heating asphalt and trucking the mix to the job.

PLANNING AND ADMINISTRATION

SPR-486: *Highway Facilities for an Aging Arizona Population*

Project Cost
$13,360

Summary
The purpose of this research project was threefold: to examine the current knowledge of state-of-the-art highway design practices aimed at increasing the safety of older drivers; assess the crash and fatality data for older drivers in Arizona; and survey older adults regarding their perceptions of Arizona's roadways and possible needs for enhancement.

Older adults increasingly make up a larger part of the driving population. Age related declines and complications from medical conditions put older drivers at higher risk of collision, and when in collision, of a fatal injury. Changes in visual acuity, cognition, use of certain medications, and functional impairment may contribute to reduced driving ability. In Arizona the research found that, like older adults nationwide, older drivers are more likely have angle and left-turn collisions, to be in collisions involving intersections and junctions, at signaled and unsignaled left-turn intersections, and in daylight hours. Older adults surveyed rated driving at night as very difficult, followed by driving on a freeway and identifying street names. They feel improvement could be made to lettering for roadway signs, intersection markings and signals, and support increasing the availability of sidewalks. Survey respondents most frequently rated larger and better-illuminated traffic signs as the most helpful design improvement that could be implemented and most frequently rated special senior driver testing programs as the most effective screening and assessment option for older drivers.

The study recommended that Arizona use locations identified in this study as having high rates of collisions involving older adults to develop test sites for roadway

improvements. The study also recommend that the state begin to review its screening, assessment and education for older drivers with the intent of developing a more stringent screening and assessment process and develop and implement self-testing for older adults to support improved driving safety.

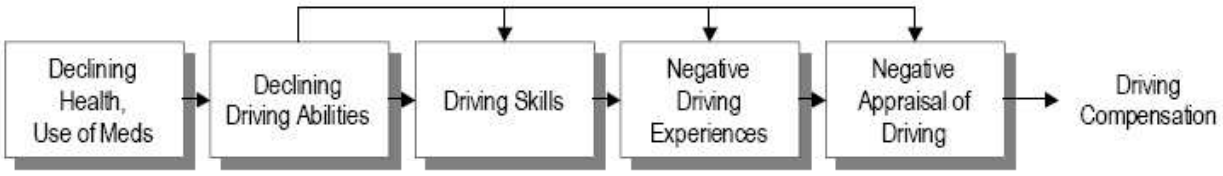


Figure 1 General Model of Influences on Driving Applied to the Older Driver[3]

Implementation

ADOT reviewed the top sites that were identified in the study for accidents involving older adults and analyzed these to determine their characteristics (e.g., the type of intersection, whether signaled or non-signaled, stop sign, illumination, etc.). Two sites were considered: State Route 95 within Bullhead City and U.S. Route 60 within the unincorporated retirement community of Sun City between mileposts 148.0 and 148.4. United States Route 60 (Grand Avenue) was selected for implementation.

The design enhancements included removing right turn channelization from all four corners, tightening turn radii, increasing left-turn storage length, larger street name signing, larger advance street name signing, using ClearView font on signs, and larger traffic signal ball indicators.

An evaluation of the changes was conducted. Preliminary results indicate favorable resident responses to the changes. Seventy nine percent of those surveyed found the intersection easier to use. Ninety nine percent found the visibility of signals to be improved. Ninety five percent found the turn lanes to be improved and 94% found street signs to be improved.

SPR-528: *Estimating the Cost of Overweight Vehicle Travel on Arizona Highways*

Project Cost
$9,400

Summary

The Arizona Department of Transportation (ADOT) has primary responsibility for enforcing laws regulating size and weight of commercial and non-commercial vehicles on the state's highways. ADOT's Motor Vehicle Division (MVD) coordinates enforcement activities. There is a concern that overweight vehicles may have a significant adverse impact on Arizona highway life spans. This equates to millions of dollars in damage that results in costs paid by highway user taxes and other sources. These expenditures for avoidable maintenance and repair reduce the capability and funding to build new highways and to maintain existing roads in a comprehensive manner. This study was directed toward identifying and quantifying these costs.

Implementation
ADOT is developing standard weighing processes at all MVD facilities. Data from mainline WIM (weigh-in-motion) sites are now available. A project is underway to upgrade roadside operation computers to expand their capability to read all transponders instead of only pre-approved vehicles. Further, remote data collection methods are being explored. A Virtual Weigh Station project is being studied to provide this data.

ADOT is redesigning MVD report forms to improve the accuracy of tracking the types of vehicles that produce the most overweight violations. New roadside operation computers will assist ADOT in identifying routes used by overweight vehicles and the time of day the violations occur. This will enable MVD to improve their enforcement efforts related to these violations. The study is also supporting requests for additional enforcement staff and technology.

SPR-578: *Evaluating and Improving the Dyed Diesel Education and Enforcement Program*

Project Cost
$14,820

Summary
The Internal Revenue Service and the state of Arizona allow diesel used for farm, construction, or other off-road use to be purchased tax-free. This tax-free diesel must be dyed red to identify it as off-road diesel and fuel suppliers must report their sales of dyed diesel on a monthly basis. The on-road use of dyed diesel deprives Arizona of highway tax revenue and in August 2002, the Arizona Department of Transportation initiated federally funded education and enforcement efforts to decrease inappropriate (i.e., on-road) use of dyed diesel. Using data collected during a project by the Arizona Department of Transportation, this study examined the effect of education and enforcement efforts on dyed diesel violations. Education and enforcement efforts were found to have a statistically significant effect on reducing dyed diesel violations in pickup trucks.

Figure 1. Diesel pickup truck registration densities.

Implementation
As a result of this study permanent funding for a dyed diesel education program will be proposed for the ADOT fiscal year 2009 budget. The budget request will include a request for two additional full-time enforcement personnel for this program. The ADOT Motor Vehicle Division is also working on an automated system to allow fuel suppliers to track and report their blending, shipment, and sale of dyed diesel.

SPR-622: *Arizona Construction Cost Index*

Project Cost
$0 (ATRC staff research study)

Summary
Fluctuations in construction costs make the tasks of estimating project and overall highway project costs difficult. The objective of this research project was to examine the price fluctuations of the most heavily used construction commodities over both the short and long terms. An index for each of these commodities has been created.

Implementation
The Arizona Transportation Research Center (ATRC) is publishing a monthly update of this construction cost index. This publication appears on the ATRC web site. Subscribers to the index are be notified by email and sent the web site link each month. [1]

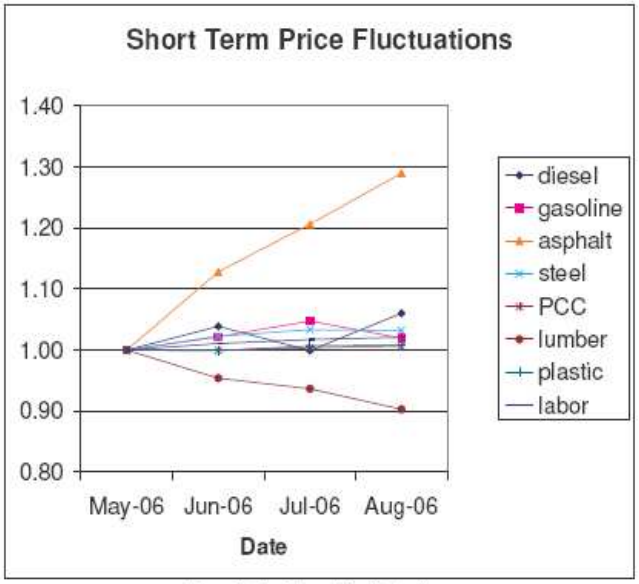


Figure 1. Short Term Price Fluctuations

[1] Web link: http://www.azdot.gov/TPD/ATRC/Publications/Price_Trends/index.asp

Appendix A

List of Projects Completed During 2006

Project No.	Project Title
SPR-371	*Maintenance Cost Effectiveness Study*
SPR-418	*Maintenance Management System Procedures*
SPR-460	*Evaluation of Cold In-Place Recycle Methods*
SPR-461	*Procedures for Winter Storm Maintenance Operations*
SPR-474	*Development of a Statewide GIS-Based Feature Inventory System*
SPR-491	*Evaluation of the Cost Benefits of Continuous Pavement Preservation Design Strategies Versus Reconstruction*
SPR-494	*Enhance the Pavement Management System so that It Can Determine Preventative Maintenance Strategy Effectiveness*
SPR-495	*A Field Study of Particulate Emissions from Major Roadways in the Phoenix Airshed*
SPR-510	*Performance of Various Types of Bridge Deck Joints*
SPR-520	*Maintenance Repair Procedures for Bridge Decks*
SPR-537	*Safety Related Data Management*
SPR-556	*Right Turn Control Study: Yield Signs or Signals for Off Ramp at Single-Point urban Traffic Interchanges*
SPR-572	*Evaluation of Benefits and Opportunities for Innovative Noise Barrier Designs*
SPR-578	*Evaluating and Improving the Dyed Diesel Education and Enforcement Program*
SPR-580	*Barcode Asset Management System*
SPR-582	*Multi Modal Use of Freeway Corridors*
SPR-622	*Arizona Construction Cost Index*

Research: The relentless pursuit of excellence.

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